Lake Mead Evaporation Study

Prepared for the Lake Mead Ecosystem Monitoring Workgroup Meeting

November 13, 2014

By Erin Orozco

U.S. Department of Interior

U.S. Geological Survey (USGS)

Lake Mead National Recreation Area

USGS science for a changing world

Reference

Presentation based on the following USGS study:

Evaporation from Lake Mead, Nevada and Arizona, March 2012 through February 2012

By Mike Moreo and Amy Swancar

Scientific Investigations Report 2013-5229

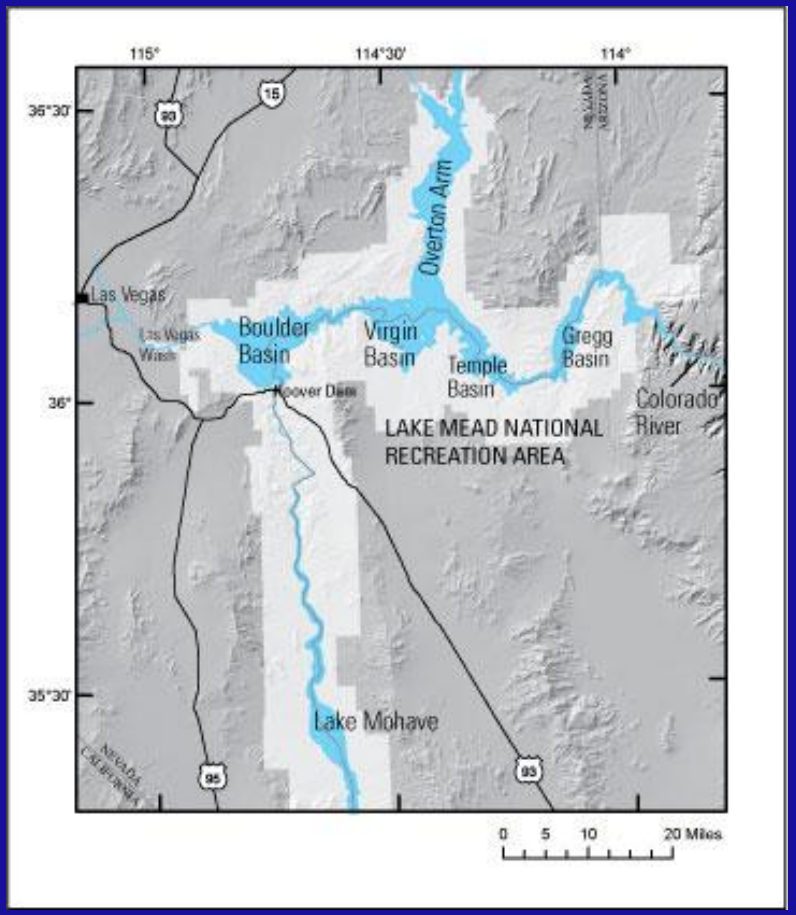
(http://pubs.usgs.gov/sir/2013/5229/pdf/sir2013-5229.pdf)

Hoover Dam – Lake Mead Reservoir

- Hoover Dam completed in 1936
- Purpose was to control floods, provide irrigation, and create hydroelectric power
- Hoover Dam created Lake Mead – the largest reservoir in the United States

Lake Mead – Fun Facts

- Surface area - 248 mi^2
  - 158,500 acres
- Capacity – 28.9 Maf
  - Enough water to cover all of Pennsylvania in 1 foot of water
- 6 million visitors in 2013
  - 3 million visitors each – Yellowstone & Yosemite NP
- Lake Mead became the first National Recreation Area in 1964



USGS science for a changing world

Previous Studies

- **Anderson and Pritchard (1951)**
  - **Part of a series of comprehensive surveys conducted by the USGS and others at Lake Mead**
  - **Annual evaporation rate = 64 inches a year**
  - **Inconclusive**

- **Lake Hefner, Oklahoma (1950-51) USGS**
  - **Water budget could be determined with sufficient accuracy**

Previous Studies Continued…

- Harbeck and Other (1958)
  - Annual evaporation rate = 85.52 inches a year (875 Kaf)
  - Nearly 3 times Nevada's annual water allocation of 300 Kaf
- U.S. Bureau of Reclamation (USBOR) 24-Month Study
  - Mass-transfer equation devised using monthly evaporation could be estimated with a combination of variables measured at Lake Mead and Las Vegas airport

Methods of Study

- **Bowen Ratio Energy Budget**
  - Energy balance method
  - Accurate for annual timescales
  - High uncertainty with quantifying monthly energy budget
- **Eddy Covariance (EC)**
  - Aerodynamic method & energy balance method
  - Accurately measure daily and sub-daily evaporation
  - Primary method of this study

Monitoring Stations - Lake Mead

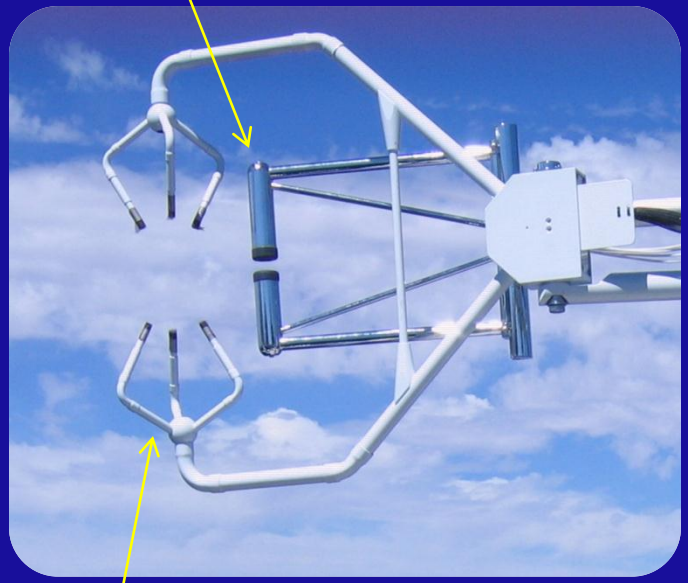
- Land-based eddy covariance
- EC-2 site
- 4 EC Sites = 25% Boulder Basin

Lake Mead National Recreation Area

USGS science for a changing world

Land-Based Equipment

- Krypton hygrometer (KH2O) – water vapor density fluctuations



- Sonic Anemometer (CSAT3) – wind vector, temperature

Land-Based Equipment Continued…

- **Bulk Precipitation**

Land-Based Monthly Servicing

- Check data from the Campbell Scientific CR3000 data logger
- Clean KH2O with DI water and Q-tip
- Check level of the CSAT3
- Check and record precipitation level in the bulk precipitation gage

Monitoring Stations - Lake Mead

- Boulder Basin Monitoring Station

USGS science for a changing world

Boulder Basin Monitoring Station Sensors

- Net radiometer
- IR temperature

Station Sensors Continued…

- Pyranometer

Station Sensors Continued…

- Temperature
- Humidity

Station Sensors Continued…

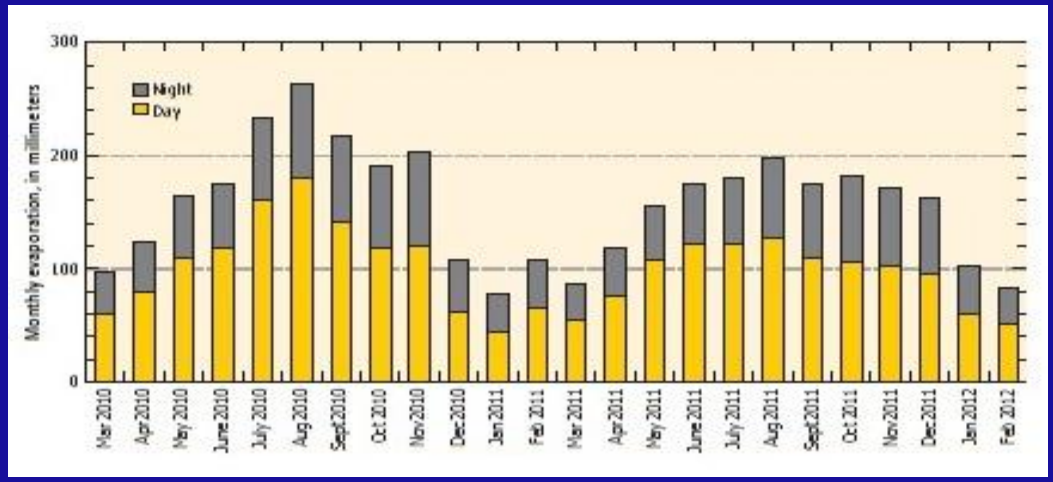
- Wind speed
- Wind direction

Boulder Basin Monitoring Station Monthly Servicing

- Check data from the Campbell Scientific CR3000 data logger
- Clear debris from sensors
- Check level of net radiometer

Evaporation Rates

- Volume of water evaporation was computed monthly
- Corrected Eddie Covariance evaporation rate and the mean lake surface area



Factors that effect evaporation:

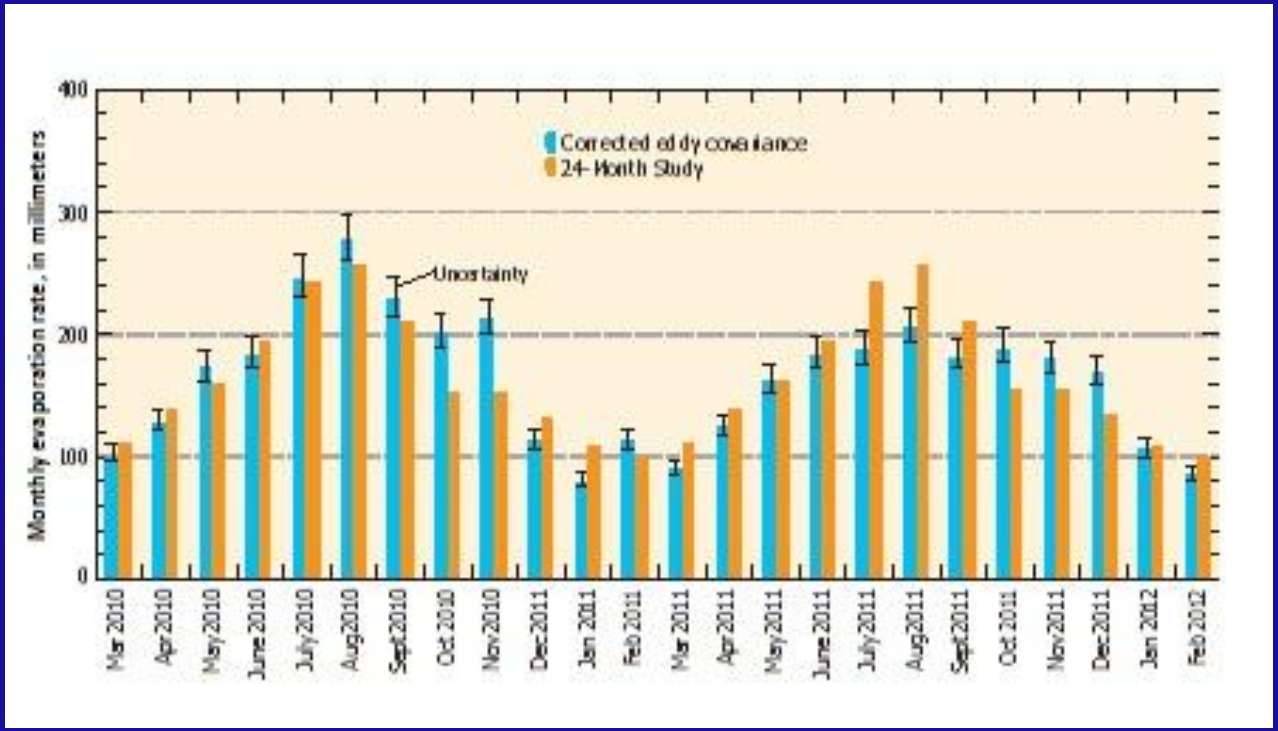
- Wind Speed
- Vapor Pressure Difference
- Air Temperature
- Lake Surface Area

24 Month Study by USBOR

- Evaporation rate estimation for this study were compared with the evaporation-rate coefficients used for the 24 month study

- Standard set of monthly evaporation-rate coefficients that do not vary from year to year

USGS vs. USBOR Evaporation Rates



USGS science for a changing world

USGS Evaporation Rates

- **March 2010 – 2011**
  - **Annual evaporation rate = 81.65 inches (584 Kaf)**
- **March 2011 – 2012**
  - **Annual evaporation rate = 74.07 inches (583 Kaf)**

Further Investigation

- On going evaporation estimates for Lake Mead
- Currently working on evaporation rates for Lake Mohave

Questions?